Chemical Contaminant Sampling and Analysis of Shellfish from Classified Harvesting Areas (2015)

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Contents

Glossary of Main Terms

Term or Acronym	General Meaning Of Term
EU	European Union
EC	European Commission
FSA	Food Standards Agency
WHO	World Health Organisation
PAHs	Polycyclic aromatic hydrocarbons
PAH 4	Sum of 4 PAHs (benzo[*a*]pyrene, benz[a]anthracene, benzo[b]fluoranthene, chrysene)
PCB	Polychlorinated biphenyl
Ortho-PCB	Ortho-substituted PCB (non planar)
Non-ortho-PCB	Non-ortho-substituted PCB (co-planar)
PCDD/F	Polychlorinated dibenzo-*p*-dioxin/ polychlorinated dibenzofuran (dioxins)
TEF	Toxic Equivalency Factor – toxicity expressed for each dioxin-like compound as a fraction of 2,3,7,8-TCDD (2,3,7,8-TCDD = 1).
TEQ	Toxic Equivalence – product of the congener concentration and the TEF
Total TEQ	Total of the Sum of all the Toxic Equivalences (TEQs) for each group of compounds
Sum of ICES 6	Sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180
fat weight	Values relevant to the assessed fat content of the sample
whole weight	Values based on the sample as received 'whole' or wet
WHO-TEQ 2005	World Health Organisation - TEQ based on values as set in 2005
LOD	Limit of Detection
LOQ	Limit of Quantification
Lower bound	assumes values at less than the limit of detection are zero (e.g.<0.01=0)
Upper bound	assumes values at less than the limit of detection are equal to the limit of detection (e.g. <0.07=0.07)
Trace Element	An element in a sample that has an average concentration of less than 100 parts per million (less than 100 mg/kg)
Heavy Metals	A loosely defined subset of elements that exhibit metallic properties (some are toxic, some are a nutritional requirement in small amounts), (This survey includes, Cr, Mn, Co, Ni, Cu, Zn, As, Se, Ag, Cd, Hg & Pb, (Chromium, manganese, cobalt, nickel, copper, zinc, arsenic, selenium, silver, cadmium, mercury and lead)
ng/kg	Nanogram per kilogram ($x10^{-9}$/ part per trillion)
µg/kg	Microgram per kilogram (x 10^{-6}/ part per billion)
mg/kg	Milligram per kilogram (x 10^{-3}/ part per million)
ICP-MS	Inductively coupled plasma-mass spectrometry
HRGC-HRMS	High resolution gas chromatography - high resolution mass spectrometry
HRGC-LRMS	High resolution gas chromatography – unit resolution mass spectrometry
LIMS	Laboratory Information Management System

Executive Summary

This study on chemical contaminants in shellfish from Scottish classified shellfish production areas, fulfils part of the requirements of EU member states (EU Regulations (EC) No.1881/2006 and (EC) No. 854/2004) to adopt appropriate monitoring measures and carry out compliance checks on shellfish produced for human consumption. In comparison to earlier years, the scope of this study was widened to include production areas that had not been tested before. Marine shellfish bio-accumulate environmental contaminants because of their inability to metabolise these during feeding. The study determines concentrations of regulated environmental contaminants in the flesh of edible species with a view to determine current levels of occurrence and to allow estimation of consumer exposure.

The study analysed seventeen composite samples of shellfish including common mussels, Pacific oysters, common cockles and razor clams for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs, dioxins), polychlorinated biphenyls (PCBs). There were forty samples tested for polycyclic aromatic hydrocarbons (PAHs) and heavy metals that included the aforementioned species with the addition of: native oysters, queen scallops, surf clams and king scallops. Once initial data was generated a further three samples were collected for the analysis of PAHs only. The methodologies used for the analyses were UKAS accredited to the ISO 17025 standard and follow EU commission regulations for data quality criteria.

The highest levels of the currently regulated PAHs were observed in a sample of mussels (S15-023706); showing concentrations of benzo[a]pyrene (BaP) at 7.59 µg/kg, and PAH 4 at 47.08 µg/kg compared to the maximum permitted level (MPL) of 5 µg/kg and 30 µg/kg respectively (Regulation (EC) No. 835/2011). One other sample, a queen scallop (S15-006259), exceeded the MPL for BaP only, with a concentration of 6.06 µg/kg. In the case of PCDD/Fs and PCBs in particular, contaminant concentrations were all below the regulatory maximum levels (Regulation (EU) No. 1259/2011). Concentrations of the regulated heavy metals, mercury, cadmium and lead were all below the set maximum limits (Regulation (EC) No. 1881/2006 as amended). Contaminant profiles from the current study are similar to the previous year's data.

Following the exceedance of MPLs for BaP and PAH 4, the areas in question were re-sampled within seven weeks of the original sample being taken and tests carried out for PAHs. The results for the re-sampled areas showed levels to be below MPLs.

1. Background to Study

Marine shellfish are an excellent source of protein, are high in essential minerals, and low in calories and fat. In many parts of the UK and in Scotland in particular, the shellfish industry makes a significant contribution to the local economy. Shellfish have a recognised potential for bio-accumulating contaminants and some bivalve species such as mussels, are commonly used as early indicators of local pollution. Bivalves feed by filtering plankton from the surrounding water that washes through their habitat. This feeding mechanism leads to the bio-accumulation of pollutants of biogenic and anthropogenic origin such as polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), heavy metals (trace elements) and polycyclic aromatic hydrocarbons (PAHs), from the surrounding waters. The bio-accumulation potential of the shellfish species used for food is particularly relevant in the case of environmental contaminants with long half-lives such as chlorinated PCDD/Fs and PCBs. These contaminants have been the subject of a number of studies (Garraud et al 2007, Lee et al 2007, Fernandes et al 2009, Fernandes et al 2012) relating to the occurrence and bio-accumulation in marine species and the resulting potential for human exposure arising from the consumption of the edible species.

In recognising the requirements of food safety, the EU has for a number of years, defined regulation for the control of these contaminants in a range of foods including shellfish. (Commission Regulation (EC) No 1259/2011, Commission Regulation (EU) No 835/2011, Commission Regulation (EC) No 333/2007). Some of the regulations specify new requirements on the controls expected by the competent authority (Food Standards Scotland) with respect to classified shellfish production areas. EU member states are required to adopt appropriate monitoring measures and carry out compliance checks with regard to the occurrence of these contaminants in shellfish produced for human consumption.

PCDD/Fs and PCBs are recognised environmental and food contaminants that are known to bio-accumulate in fish and shellfish. The extent of this accumulation is evident by the levels of these contaminants detected in various studies. In the UK, Total Diet Studies (TDS) (FSA 2003) carried out over the last two decades; fish (including shellfish) has consistently been one of the highest dioxin and PCB containing food groups. Human dietary exposure can therefore be significantly influenced by the fish and shellfish component of the diet, particularly in high level consumers and low body-weight individuals.

Although metabolised in many fish species, PAHs persist in shellfish as filter feeding species appear unable to affect bio-transformation of these contaminants. Other than this bio-accumulation pathway, PAHs can also arise in fish and shellfish through some food preparation and processing methods – e.g. smoked fish are known to contain elevated levels of PAHs. Some PAH compounds have been shown to be genotoxic and carcinogenic, the most studied of which (benzo[a]pyrene, or B[a]P) is regulated in a range of foods including shellfish, within the EU (SCF Opinion 2002, Commission Regulation (EC) No. 208/2005). However, more recent evaluation by EFSA's CONTAM panel, concluded that a set of 4 compounds, namely benzo[a]pyrene, chrysene, benz[a]anthracene and benzo[b]fluoranthene (collectively referred to as PAH4) were more suitable indicators of PAH toxicity in food (EFSA, 2008). These four compounds were subsequently included in the updated Commission Regulation (EC) No. 835/2011, which came into force from September 2012. In a study on bivalve molluscs including mussels, oysters and scallops, the FSA reported positive detection of most PAH compounds in samples taken in England and Wales (FSA 2005). However in comparison to a study carried out about a decade earlier, reported levels were significantly lower and no sample showed levels above the 5 µg/kg EU limit for BaP in shellfish.

Some trace elements and in particular, heavy metals are established toxic contaminants. Some elements, such as copper, chromium, selenium and zinc are essential to health but may be toxic at high levels of exposure. Metals and other elements may enter marine and aquatic environments and bio-accumulate in species at any point during growth and harvesting. Some potentially toxic elements occur naturally as part of the local geology, but others may also be found in the location of certain industries, as a result of unauthorised discharge, or as a result of other anthropogenic activity.

As part of its monitoring requirements in support of EU regulations, Food Standards Scotland (FSS) has overseen the collection of shellfish each year, from classified shellfish production sites within relevant local authority areas. The production sites are required to monitor shellfish samples, with the edible tissues analysed for the contaminants described above, as specified in Commission Regulation (EU) No. 252/2012. Sampling officers from Scotland were required to obtain suitable shellfish samples from designated sampling points within classified shellfish production areas, as defined by the FSS. The collection of shellfish and transport logistics were co-ordinated by Cefas. Samples were taken and live shellfish sent to Fera, with the edible tissues analysed for the contaminants described above, as specified in Commission Regulation (EU) No. 252/2012. The analysis is carried out at Fera in York.

Fera has generated environmental contaminant data on shellfish collected from new and existing shellfish sites in Scotland since 2007. This report collates the results of the individual analyses for dioxins, PAHs and heavy metals in samples of shellfish collected from Scottish sites in the first quarter of 2015.

2. Method

2.1 Sample Collection and Preparation

Forty three samples of shellfish, including species such as common mussels, Pacific oysters, common cockles, razor clams, native oysters, queen scallops, surf clams and king scallops were collected during January to March 2015. The sampling period was timed to coincide with the period of optimal contaminant concentrations in the shellfish.

Details on the locations, with descriptions of the samples and identification are given in Table 1.

On receipt at the laboratory each sample was given a unique laboratory reference number and the sample details were logged into a database using LIMS. The samples were stored frozen prior to analysis. Sample preparation consisted of shelling followed by thorough homogenisation and aliquots taken for PAH and heavy metal analysis, prior to freeze-drying. Freeze-dried sample powders were re-homogenised and aliquots used for dioxin and PCB analysis.

2.2 Contaminants measured – Specific Analytes

The following analytes were determined: Regulated contaminants are highlighted in **bold.**

Dioxins - all 17, 2378-Cl substituted PCDDs and PCDFs.

Dioxin-like PCBs - IUPAC no. 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169 and 189.

Non Dioxin-like PCBs - IUPAC numbers 18, **28**, 31, 47, 49, 51, **52**, 99, **101**, 128, **138**, **153** and **180**.

PAHs -

acenaphthene, acenaphthylene, fluorene, phenanthrene, anthracene, fluoranthene, benzo[c]fluorene, pyrene, benzo[e]pyrene, benzo[b]naptho[2,1-d]thiophene, anthanthrene, coronene, benzo[ghi]fluoranthene, **benz[a]anthracene**, **chrysene**, **benzo[b]fluoranthene**, benzo[j]fluoranthene, benzo[k)fluoranthene, **benzo[a]pyrene**, cyclopenta[c,d]pyrene, indeno[123cd]pyrene, dibenzo[ah]anthracene, benzo[ghi]perylene, dibenzo[al]pyrene, dibenzo[ae]pyrene, dibenzo[ai]pyrene, dibenzo[ah]pyrene and the substituted PAH, 5-methylchrysene.

Heavy Metals – Chromium (Cr), Manganese (Mn), Cobalt (Co), Nickel (Ni), Copper (Cu), Zinc (Zn), Arsenic (As), Selenium (Se), Silver (Ag), **Cadmium** (**Cd), Mercury (Hg), Lead (Pb)**

2.3 PCDD/F and PCB - Analytical Methodology

(FERA (UK NRL) SOPs FSG 453-460)

The method used for the preparation, extraction and analysis of samples has been reported previously (Fernandes et al 2004) and is part of the CEN EN16215:2012 standard. In brief, samples were fortified with ^{13}C-labelled analogues of target compounds and exhaustively extracted using mixed organic solvents. Ortho substituted PCBs were separated from non-ortho substituted PCBs and PCDD/Fs by fractionation on activated carbon. The two fractions were further purified using adsorption chromatography on alumina. Analytical measurement was carried out using high resolution gas chromatography-high resolution mass spectrometry (HRGC-HRMS) for the seventeen, 2,3,7,8-Cl substituted PCDD/F congeners and non-ortho substituted PCBs. HRGC-unit resolution mass spectrometry (HRGC-LRMS) was used for the measurement of the ortho substituted PCBs.

All analyses were UKAS accredited to ISO 17025 standards, with the inclusion of reference material and method blanks which were evaluated prior to reporting. Further quality assurance measures included the successful participation in international inter-comparison exercises such as Dioxins in Food-2013 and Dioxins in Food-2014, on dioxins and dioxin-like PCBs. Quality control evaluation for the accompanying data follows the criteria specified for chlorinated dioxins and PCBs (Commission Regulation (EU) No 252/2012). In addition, as NRL for chemical contaminants, FERA participates in PT exercises and other inter-laboratory exercises as organised by the EU-RL, and achieves consistently good results.

2.4 Polycyclic Aromatic Hydrocarbons (PAH) - Analytical Methodology

(FERA (UK NRL) SOP FSG 410)

The analytical methodology for the PAHs has been reported before (Rose et al, 2007) and is based on internal standardisation with GC-MS measurement. An aliquot of the homogenised sample was fortified with ^{13}C-labelled analogues of target compounds and saponified with methanolic potassium hydroxide. The extracted PAH solutions were purified in two stages with a DMF/cyclohexane partition followed by adsorption chromatography on activated silica. Purified extracts were sensitivity standardised and measured using high resolution gas chromatography-unit resolution mass spectrometry.

The analytical procedure for PAHs is UKAS accredited to the ISO 17025 standard and includes the assessment of method blanks and reference materials, (e.g. T0654, PAHs in palm oil) for

compliance with the accreditation criteria. The methodology also meets the criteria required for evaluating data against the maximum permitted limits for benzo[a]pyrene as specified in EU Commission Regulations. FERA regularly participates in FAPAS PT exercises for PAHs in food. In addition, as NRL for chemical contaminants, FERA participates in PT exercises and other inter-laboratory exercises as organised by the EU-RL and achieves consistently good results.

2.5 Trace Elements - Analytical Methodology

(Fera (UK NRL) SOP FSG 461 and 457)

Aliquots of the homogenised sample were weighed into allotted digestion vessels and a mixture (4:1) of nitric acid and hydrochloric acid added. The vessels were capped and the contents digested using a high pressure microwave digestion system. Reagent blanks, certified reference materials and a spiked sample were also taken through the procedure. The resulting solutions were transferred to pre-marked acid-clean plastic test tubes and diluted to 10 ml with deionised water. The digest solutions together with a set of standards covering the expected concentration range, were internally standardised with indium or rhodium in dilute nitric acid (1 %v/v). Measurements were made using an Agilent 7700x ICP-MS with collision cell.

In common with the other two sets of analyses, the analytical procedure is accredited to the ISO17025 standard. The criteria used to assess data included checks on instrument drift, spike recovery, replicate agreement, limits of detection and certified reference material values. Regular, successful participation in FAPAS inter-comparison exercises provides further confidence in the data. In addition, as NRL for chemical contaminants, Fera participates in PT exercises and other inter-laboratory exercises as organised by the EU-RL and achieves consistently good results.

3. Results

Analyte concentrations are presented in Tables 2.1 to 2.6. Concentration units reflect current convention as required by regulation, and data were rounded to two decimal places or as appropriate. The reporting limits (quoted as "<") for dioxins, PCBs and PAHs are estimated as a dynamic parameter and therefore represent the limits of determination that prevail during the course of the measurement. For PCDD/Fs, PCBs, metals and PAHs, the reporting limits are consistent with the requirements of EU regulations. Data on the reference materials that were analysed concurrently with the samples, were within established acceptable limits, and are available if required. Measurement uncertainty (MU) was calculated and applied to data following guidelines and principals set out in Measurement Uncertainty For Persistent Organic Pollutants By Isotope-Dilution Mass Spectrometry (Epp, et al 2014). MU and reference material data can be made available if required.

In addition to the concentration of individual congeners, the dioxin-like toxicity of the samples arising from PCDD/Fs and dioxin-like PCBs has also been reported as a toxic equivalent (WHO-TEQ), which is calculated by multiplying the concentration of each congener of interest by its toxicity equivalency factor (WHO-TEF). The TEQs are presented in terms of the 2005 TEFs (van den Berg et al 2006). Additionally as per the requirements of Regulation 1259/2011, the sum of the ICES-6 PCBs is also provided. The regulations for shellfish are based on whole weight concentrations; however in keeping with previous reports to Food Standards Scotland, the results for PCDD/Fs and PCBs have also been reported on a fat weight basis.

PCDD/Fs and PCBs were detected in all samples at levels well within the regulatory limits. The combined PCDD/F + PCB TEQ ranged from 0.05 pg TEQ/g to 0.39 pg TEQ/g. For most of the samples PCDD/Fs contributed approximately half to the total TEQ. The exception was a common cockles sample (S15-038711) from Ganavan where *non-ortho* PCBs contributed approximately 85% the total TEQ.

The concentration of ICES-6 PCB ranged from 0.06 µg/kg to 2.58 µg/kg, with the highest levels found in Pacific oysters (S15-000387).

PAHs were detected in all forty three samples analysed. Higher molecular weight PAHs such as anthanthrene and the dibenzopyrenes were either not found above the LOQ or at relatively low levels in all of the samples. BaP concentrations ranged from 0.08 µg/kg to 7.59 µg/kg and PAH4 concentrations ranged from 0.62 µg/kg to 47.08 µg/kg. The two highest concentrations for the regulated compounds were observed in a sample of mussels (S15-023706) collected from Loch Leven Lower, exceeding MPL for BaP (set at 5 µg/kg) and PAH4 (set at 30 µg/kg). One other

sample, a queen scallop (S15-006259) collected from Loch Fyne-Stonefield, exceeded MPL for BaP only, showing a concentration of 6.06 µg/kg.

Following the exceedance of MPLs for benzo[a]pyrene and PAH 4, the areas in question, Loch Fyne – Stonefield, Loch Leven Lower and additionally Loch Leven Upper (as this area neighbours Loch Leven Lower and has a history of elevated chemical contaminants being found) were re-sampled and tests were carried out for PAHs. The results for the re-sampled areas all showed levels to be below MPLs. The follow up sample details are below the original details in table 1 and the follow up results are included alongside the original sample data in the results table 2.5.

Heavy metals were detected in all samples. The four most abundant heavy metals were zinc (Zn), manganese (Mn) and copper (Cu), with Zn present at the highest concentration. Concentrations of the regulated heavy metals mercury (Hg), cadmium (Cd) and lead (Pb) were all below the regulatory limit (Commission Regulation EC 1881/2006 as amended by 629/2008).

In general, the patterns and levels of the three contaminant classes were consistent with those recorded last year.

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Table 1: Overview of Samples

Local Authority	Production Area	Site name	Collection period	Sample type	GR or *NGR for sample	Fera LIMS no.
Argyll & Bute Council	Loch Spelve - Groggan Pier	Croggan Pier	06/01/2015	Pacific Oysters	NM7078027340	S15-000239
Argyll & Bute Council	Otter Ferry	Balliemore	26/01/2015	Pacific Oysters	NR 9217583500	S15-020909
Argyll & Bute Council	Loch Fyne - Stonefield	North Bay	21/01/2015	Queen Scallops	NR8649272262	S15-006259
Argyll & Bute Council	Loch Fyne - Stonefield	North Bay (re-sample)	17/03/2015	Pacific Oysters	NR 86492 72262	S15-040615
Argyll & Bute Council	West Jura	Jura	20/01/2015	Razors	NR4684886236, unverified	S15-006260
Argyll & Bute Council	Dunstaffnage Cockles	Dunstaffnage Bay	21/01/2015	Cockles	NM8897234200	S15-006258
Argyll & Bute Council	Kerrera Cockles	Ganavan	18/02/2015	Cockles	NM8553732386	S15-038711
Argyll & Bute Council	Kilfinichen Bay	Kilfinichen Bay	20/01/2015	Cockles	NM4886228335	S15-003451
Argyll & Bute Council	Loch Riddon Cockles	Loch Riddon Cockles	11/02/2015	Cockles	NS0116178790	S15-038453
Argyll & Bute Council	Machrie Bay	Machrie Bay Razors	19/01/2015	Razors	NR8879733466	S15-003449
Argyll & Bute Council	Saddell Bay	Saddell Bay Razors	03/02/2015	Razors	NR7918231383, unverified	S15-024039
Dumfries & Galloway	Loch Ryan	Loch Ryan	12/01/2015	Native Oysters	DG19117412	S15-000369
Dumfries & Galloway	Luce Bay	Luce Sand Razors	18/01/2015	Razors	DG-499-865-16	S15-000676
East Lothian	Gullane Point North	Gullane North	05/01/2015	Razors	EL-601-1087-16	S15-000219
East Lothian	Gullane Point South	Gullane South	05/01/2015	Razors	EL-703-1525-16	S15-000216
Fife	Firth of Forth North	Anstruther	05/01/2015	Surf Clams	(FF-068-184-19)	S15-000121

Local Authority	Production Area	Site name	Collection period	Sample type	GR or *NGR for sample	Fera LIMS no.
Fife	Forth Estuary - Largo Bay	Largo Bay	05/01/2015	Razors	NO 44510223, unverified	S15-000223
Highland: Ross and Cromarty	Loch Kanaird	Ardmair	19/01/2015	Pacific Oysters	NH11837 99190	S15-000679
Highland: Ross and Cromarty	Loch Ewe & Loch Thurnaig	Loch Ewe	09/03/2015	King Scallops	NG857 888, unverified	S15-040049
Highland:Lochaber	Loch Leven Upper	Upper	27/01/2015	Mussels	NN1478361691	S15-023705
Highland:Lochaber	Loch Leven Upper	Upper (re-sample)	17/03/2015	Mussels	NN14782 61698	S15-040524
Highland:Lochaber	Loch Leven Lower	Lower	27/01/2015	Mussels	NN0715659069	S15-023706
Highland:Lochaber	Loch Leven Lower	Lower (re-sample)	17/03/2015	Mussels	NN 08137 58664	S15-040523
Highland: Sutherland	Loch Inchard	Loch Inchard - Site 1 - D. Ross	13/01/2015	Mussels	NC22185597	S15-000388
Highland: Sutherland	Loch Glencoul	Kylesku	13/01/2015	Mussels	NC24073405	S15-000394
Highland: Sutherland	Kyle of Tongue	Kyle of Tongue	04/02/2015	Pacific Oysters	NC59165882	S15-024036
Highland: Sutherland	Dornoch Firth 2 (Just listed as Dornoch Firth on sample sheet)	Meikle Ferry (just listed as Dornoch Firth on sample sheet)	16/02/2015	Mussels	NH77548504	S15-038579
Lewis and Harris	Broad Bay Aignish	Aiginish	18/02/2015	Razors	NB 46403540, unverified	S15-038712
Lewis and Harris	Loch Leurbost	Eilean Mhiabhaing	03/02/2015	Mussels	NB37442466	S15-023929
Lewis and Harris	East Loch Tarbert	Sound of Scalpay	04/02/2015	Mussels	NG22299758	S15-024041
Lewis and Harris	Loch Roag: Barraglom	Loch Barraglom	10/02/2015	Mussels	NB16673413	S15-038370
North Ayrshire	Fairlie	Southannan Sands	13/01/2015	Pacific Oysters	NS19845430	S15-000387
Shetland	Stromness Voe	Burra Holm	19/01/2015	Mussels	HU38574556	S15-000674
Shetland	Clift Sound - Booth	Booth	21/01/2015	Mussels	HU40193778	S15-006257
Shetland	Vaila Sound: East of Linga & Galtaskerry	Whitesness	19/01/2015	Mussels	HU24394760	S15-000675

Local Authority	Production Area	Site name	Collection period	Sample type	GR or *NGR for sample	Fera LIMS no.
Shetland	Baltasound Mussels	Baltasound Harbour	06/01/2015	Mussels	HP 64540887	S15-000218
Shetland	Olnafirth Inner	Inner	05/01/2015	Mussels	HU 39696361	S15-000120
Shetland	Mid Yell Voe	Seafield	06/01/2015	Mussels	HU51389193	S15-000221
Shetland	East Burwick Mussels	East Burwick Mussels	02/02/2015	Mussels	HU39064012	S15-023880
Shetland	Hamar Voe	Hamar Voe	13/01/2015	Mussels	HU 3071 7614	S15-000424
Uist and Barra	Traigh Mhor	Traigh Mhor	26/01/2015	Cockles	NF70360497	S15-023658
Uist and Barra	North Ford	Oitir Mhor	03/02/2015	Cockles	NF84055786	S15-023927
Uist and Barra	Caolas Bhearnaraigh	Caolas Bhearnaraigh	03/02/2015	Razors	NF910 769, unverified	S15-023928

Quality statement: Information relating to the origin of the samples (place, date of collection and GR/NGR details) is as provided by sampling staff and has not undergone verification checks by Fera/Cefas.

Table 2.1: PCDD/Fs (dioxins) concentrations - Whole weight

Note: results maked with an “i” are indicative

Fera LIMS Sample No.	S15-006258	S15-038711	S15-003451	S15-038453	S15-003449	S15-024039	S15-000219	S15-000216	S15-000223
Sample Type	Cockles	Cockles	Cockles	Cockles	Razors	Razors	Razors	Razors	Razors
Production area	Dunstaffnage Cockles	Kerrera Cockles	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay	Saddell Bay	Gullane Point North	Gullane Point South	Forth Estuary - Largo Bay
Site name	Dunstaffnage Bay	Ganavan	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay Razors	Saddell Bay Razors	Gullane North	Gullane South	Largo Bay
Whole weight									
pg/g									
2,3,7,8-TCDD	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01
1,2,3,7,8-PeCDD	<0.01	<0.01	<0.01	<0.01	0.02	0.01i	0.03	0.03	0.03
1,2,3,4,7,8-HxCDD	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
1,2,3,6,7,8-HxCDD	<0.01	<0.01	<0.01	0.02	0.02	0.02	0.06	0.06	0.05
1,2,3,7,8,9-HxCDD	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.02	0.02	0.02
1,2,3,4,6,7,8-HpCDD	0.06	0.06	0.04	0.12	0.17	0.12	0.34	0.33	0.27
OCDD	0.37	0.29	0.16	0.59	1.13	0.77	1.11	1.07	0.91
2,3,7,8-TCDF	0.02	0.02	0.01	0.05	0.34	0.26	0.23	0.22	0.21
1,2,3,7,8-PeCDF	<0.01	<0.01	<0.01	0.02	0.02	0.02	0.01	0.01	0.01
2,3,4,7,8-PeCDF	0.01	0.01	0.01	0.03	0.08	0.07	0.06	0.06	0.05
1,2,3,4,7,8-HxCDF	<0.01	<0.01	<0.01	0.02	0.02	0.02	0.02	0.02	0.02
1,2,3,6,7,8-HxCDF	<0.01	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01	0.01
1,2,3,7,8,9-HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,4,6,7,8-HxCDF	<0.01	<0.01	<0.01	0.02	0.02	0.02	0.02	0.02	0.01
1,2,3,4,6,7,8-HpCDF	0.03	0.02	0.02	0.04	0.06	0.06	0.07	0.07	0.07
1,2,3,4,7,8,9-HpCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
OCDF	0.02	0.02	0.01	0.06	0.07	0.06	0.06	0.06	0.06
WHO-TEQ 2005 (pg/g) lower	**0.01**	**0.01**	**<0.01**	**0.02**	**0.09**	**0.07**	**0.10**	**0.10**	**0.09**
WHO-TEQ 2005 (pg/g) upper	**0.03**	**0.03**	**0.03**	**0.05**	**0.10**	**0.08**	**0.10**	**0.10**	**0.09**

Fera LIMS Sample No.	S15-000679	S15-023706	S15-038579	S15-038712	S15-000387	S15-023880	S15-000424	S15-023928
Sample Type	Pacific Oysters	Mussels	Mussels	Razors	Pacific Oysters	Mussels	Mussels	Razors
Production area	Loch Kanaird	Loch Leven Lower	Dornoch Firth	Broad Bay Aignish	Fairlie	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Site name	Ardmair	Lower	Meikle Ferry	Aiginish	Southannan Sands	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Whole weight								
pg/g								
2,3,7,8-TCDD	<0.01	0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
1,2,3,7,8-PeCDD	0.02	0.03	<0.01	0.01	0.06	0.02i	0.01	0.01
1,2,3,4,7,8-HxCDD	0.01	0.02	<0.01	<0.01	0.01	0.01	<0.01	<0.01
1,2,3,6,7,8-HxCDD	0.02	0.04	<0.01	0.01	0.04	0.03	0.01	0.01
1,2,3,7,8,9-HxCDD	0.01	0.02	<0.01	0.01	0.02	0.02	<0.01	<0.01
1,2,3,4,6,7,8-HpCDD	0.01	0.15	0.06	0.08	0.08	0.12	0.05	0.07
OCDD	0.05	0.58	0.24	0.39	0.27	0.34	0.12	0.26
2,3,7,8-TCDF	0.13	0.18	0.05	0.11	0.72	0.23	0.07	0.09
1,2,3,7,8-PeCDF	0.01	0.05	0.01	0.01	0.06	0.03	0.02	<0.01
2,3,4,7,8-PeCDF	0.04	0.11	0.02	0.04	0.21	0.10	0.05	0.03
1,2,3,4,7,8-HxCDF	<0.01	0.02	<0.01	0.01	<0.01	0.01	<0.01	<0.01
1,2,3,6,7,8-HxCDF	<0.01	0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01
1,2,3,7,8,9-HxCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,3,4,6,7,8-HxCDF	0.01	0.03	0.01	0.01	0.03	0.03	0.02	0.01
1,2,3,4,6,7,8-HpCDF	<0.01	0.02	0.02	0.03	0.01	0.03	0.02	0.03
1,2,3,4,7,8,9-HpCDF	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
OCDF	<0.01	0.03	0.02	<0.03	0.03	0.05	0.02	0.02
WHO-TEQ 2005 (pg/g) lower	**0.05**	**0.11**	**0.01**	**0.04**	**0.23**	**0.09**	**0.04**	**0.03**
WHO-TEQ 2005 (pg/g) upper	**0.06**	**0.11**	**0.04**	**0.05**	**0.23**	**0.10**	**0.05**	**0.05**

Table 2.1: PCDD/Fs (dioxins) concentrations - Lipid weight

Fera LIMS Sample No.	S15-006258	S15-038711	S15-003451	S15-038453	S15-003449	S15-024039	S15-000219	S15-000216	S15-000223
Sample Type	Cockles	Cockles	Cockles	Cockles	Razors	Razors	Razors	Razors	Razors
Production area	Dunstaffnage Cockles	Kerrera Cockles	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay	Saddell Bay	Gullane Point North	Gullane Point South	Forth Estuary - Largo Bay
Site name	Dunstaffnage Bay	Ganavan	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay Razors	Saddell Bay Razors	Gullane North	Gullane South	Largo Bay
Lipid weight									
pg/g									
2,3,7,8-TCDD	0.61	<0.29	<0.7	0.98	0.71	1.00	0.81	0.95	0.81
1,2,3,7,8-PeCDD	<1.39	1.25	1.04	1.28	1.35	1.66i	1.77	2.30	2.26
1,2,3,4,7,8-HxCDD	1.03	1.07	1.00	1.18	0.80	0.67	0.91	0.76	0.87
1,2,3,6,7,8-HxCDD	2.32	2.09	2.57	3.89	1.76	2.61	3.44	4.42	3.76
1,2,3,7,8,9-HxCDD	1.97	1.18	2.04	2.67	0.70	1.23	1.40	1.88	1.50
1,2,3,4,6,7,8-HpCDD	18.13	15.25	14.61	28.63	12.74	16.63	20.49	26.24	20.49
OCDD	105.03	68.41	61.11	145.50	87.44	104.13	67.65	85.94	68.02
2,3,7,8-TCDF	5.81	5.40	4.87	12.27	26.01	35.74	13.95	17.52	16.02
1,2,3,7,8-PeCDF	2.74	2.28i	2.96	3.96	1.85	2.92	0.74	1.03	0.92
2,3,4,7,8-PeCDF	3.61	2.72	3.83	6.66	6.23	9.75	3.53	4.86	3.94
1,2,3,4,7,8-HxCDF	2.58	2.02	2.35	4.53	1.58	2.46	1.05	1.39	1.19
1,2,3,6,7,8-HxCDF	2.32	1.65	2.22	2.16	1.17	1.43	0.57	0.63	0.77
1,2,3,7,8,9-HxCDF	<0.16	<0.44	<0.22	<0.34	<0.11	<0.2	<0.08	<0.1	<0.06
2,3,4,6,7,8-HxCDF	2.65	1.32i	2.48	3.92	1.45	2.20	1.04	1.30	0.94
1,2,3,4,6,7,8-HpCDF	7.45	5.40	6.52	10.82	4.98	8.19	4.17	5.25	5.28
1,2,3,4,7,8,9-HpCDF	0.71	0.59	0.61	1.52	0.30	0.43	0.18	0.20	0.16
OCDF	5.84	4.67	4.09	15.69	5.44	8.01	3.51	5.00	4.15
WHO-TEQ 2005 (pg/g) lower	**3.94**	**3.84**	**4.27**	**7.90**	**7.54**	**10.59**	**6.17**	**7.87**	**7.07**
WHO-TEQ 2005 (pg/g) upper	**5.35**	**4.18**	**4.99**	**7.93**	**7.55**	**10.61**	**6.17**	**7.88**	**7.07**

Fera LIMS Sample No.	S15-000679	S15-023706	S15-038579	S15-038712	S15-000387	S15-023880	S15-000424	S15-023928
Sample Type	Pacific Oysters	Mussels	Mussels	Razors	Pacific Oysters	Mussels	Mussels	Razors
Production area	Loch Kanaird	Loch Leven Lower	Dornoch Firth	Broad Bay Aignish	Fairlie	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Site name	Ardmair	Lower	Meikle Ferry	Aiginish	Southannan Sands	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Lipid weight								
pg/g								
2,3,7,8-TCDD	0.61	0.93	0.91	0.22	1.15	0.70	0.78	0.16
1,2,3,7,8-PeCDD	2.29	2.63	1.32	0.65	4.26	2.04i	2.36	0.94
1,2,3,4,7,8-HxCDD	0.99	1.72	1.15	0.30	0.89	1.33	1.11	0.35
1,2,3,6,7,8-HxCDD	1.52	3.68	1.66	0.58	3.03	3.16	2.48	0.87
1,2,3,7,8,9-HxCDD	0.99	1.99	1.39	0.54	1.46	1.49	1.17	0.64
1,2,3,4,6,7,8-HpCDD	1.45	12.36	11.22	4.23	5.20	11.58	9.56	5.39
OCDD	5.15	49.56	47.30	19.37	18.34	32.56	23.64	19.68
2,3,7,8-TCDF	12.16	15.15	8.98	5.56	49.26	22.36	13.55	6.55
1,2,3,7,8-PeCDF	1.32	4.27	2.83	0.55	4.06	3.36	4.20	0.75
2,3,4,7,8-PeCDF	3.61	9.22	3.87	1.89	14.22	9.51	8.71	2.08
1,2,3,4,7,8-HxCDF	<0.09	1.42	1.13	0.58	0.15	1.23	1.46	0.67
1,2,3,6,7,8-HxCDF	0.44	1.20	0.91	0.36	1.20	1.27	1.44	0.51
1,2,3,7,8,9-HxCDF	<0.02	<0.25	<0.5	<0.14	<0.02	0.49	<0.2	<0.12
2,3,4,6,7,8-HxCDF	1.12	2.67	2.07	0.62	2.21	2.80	3.10	0.80
1,2,3,4,6,7,8-HpCDF	0.11	1.66	4.44	1.62	0.85	3.17	2.91	2.27
1,2,3,4,7,8,9-HpCDF	<0.07	<0.33	<0.63	<0.36	0.10	0.34	<0.51	0.23
OCDF	<0.49	2.67	3.77	<1.35	2.11	4.76	3.73	1.81
WHO-TEQ 2005 (pg/g) lower	**5.76**	**9.39**	**5.38**	**2.37**	**15.69**	**9.27**	**8.44**	**2.87**
WHO-TEQ 2005 (pg/g) upper	**5.77**	**9.42**	**5.43**	**2.39**	**15.69**	**9.27**	**8.47**	**2.88**

Table 2.2: Non-*ortho* PCB concentrations

FERA LIMS Sample No.	S15-006258	S15-038711	S15-003451	S15-038453	S15-003449	S15-024039	S15-000219	S15-000216	S15-000223
Sample Type	Cockles	Cockles	Cockles	Cockles	Razors	Razors	Razors	Razors	Razors
Production area	Dunstaffnage Cockles	Kerrera Cockles	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay	Saddell Bay	Gullane Point North	Gullane Point South	Forth Estuary - Largo Bay
Site name	Dunstaffnage Bay	Ganavan	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay Razors	Saddell Bay Razors	Gullane North	Gullane South	Largo Bay
Whole Weight									
pg/g									
PCB77	0.59	18.38	0.29	3.27	9.59	8.33iR	12.24	11.94	11.27
PCB81	0.03	1.02	0.01	0.12	0.36	0.31	0.95	0.94	0.87
PCB126	0.12	2.11	0.06	0.22	0.53	0.45iR	0.92	0.88	0.83
PCB169	0.07	0.30	0.04	0.06	0.09	0.06	0.17	0.16	0.15
WHO-TEQ 2005 (pg/g) lower	**0.01**	**0.22**	**0.01**	**0.02**	**0.06**	**0.05**	**0.10**	**0.09**	**0.09**
WHO-TEQ 2005 (pg/g) upper	**0.01**	**0.22**	**0.01**	**0.02**	**0.06**	**0.05**	**0.10**	**0.09**	**0.09**
Lipid Weight									
pg/g									
PCB77	166.79	2062.47	111.73	811.01	739.73	1131.18iR	748.39	957.11	840.20
PCB81	8.68	114.11	5.65	30.19	27.48	42.60	58.38	75.76	65.15
PCB126	33.14	236.97	21.92	53.75	40.70	61.02iR	56.41	70.86	62.16
PCB169	19.62	33.69	14.05	15.35	6.86	8.83	10.36	13.08	11.15
WHO-TEQ 2005 (pg/g) lower	**3.92**	**24.95**	**2.63**	**5.93**	**4.36**	**6.49**	**6.04**	**7.60**	**6.65**
WHO-TEQ 2005 (pg/g) upper	**3.92**	**24.95**	**2.63**	**5.93**	**4.36**	**6.49**	**6.04**	**7.60**	**6.65**

FERA LIMS Sample No.	S15-000679	S15-023706	S15-038579	S15-038712	S15-000387	S15-023880	S15-000424	S15-023928
Sample Type	Pacific Oysters	Mussels	Mussels	Razors	Pacific Oysters	Mussels	Mussels	Razors
Production area	Loch Kanaird	Loch Leven Lower	Dornoch Firth	Broad Bay Aignish	Fairlie	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Site name	Ardmair	Lower	Meikle Ferry	Aiginish	Southannan Sands	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Whole Weight								
pg/g								
PCB77	1.69	2.16	0.61	2.00	18.75	2.66iR	0.64	1.13iR
PCB81	0.11	0.14	0.04	0.14	0.73	0.13	0.05	0.06
PCB126	0.26	0.44	0.14	0.25	1.33	0.73iR	0.21	0.16iR
PCB169	0.07	0.18	0.04	0.05	0.16	0.12	0.06	0.04
WHO-TEQ 2005 (pg/g) lower	**0.03**	**0.05**	**0.02**	**0.03**	**0.14**	**0.08**	**0.02**	**0.02**
WHO-TEQ 2005 (pg/g) upper	**0.03**	**0.05**	**0.02**	**0.03**	**0.14**	**0.08**	**0.02**	**0.02**
Lipid Weight								
pg/g								
PCB77	163.53	183.07	121.97	100.55	1290.26	255.64iR	124.14	86.64iR
PCB81	10.98	11.57	7.64	6.80	50.45	12.91	8.80	4.84
PCB126	25.21	37.76	27.75	12.71	91.40	69.9iR	40.33	12.06iR
PCB169	6.39	15.55	8.91	2.54	10.88	11.95	12.24	2.86
WHO-TEQ 2005 (pg/g) lower	**2.73**	**4.26**	**3.06**	**1.36**	**9.61**	**7.38**	**4.42**	**1.30**
WHO-TEQ 2005 (pg/g) upper	**2.73**	**4.26**	**3.06**	**1.36**	**9.61**	**7.38**	**4.42**	**1.30**

Table 2.3: *Ortho* PCB concentrations – Whole weight

FERA LIMS Sample No.	S15-006258	S15-038711	S15-003451	S15-038453	S15-003449	S15-024039	S15-000219	S15-000216	S15-000223
Sample type	Cockles	Cockles	Cockles	Cockles	Razors	Razors	Razors	Razors	Razors
Production area	Dunstaffnage Cockles	Kerrera Cockles	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay	Saddell Bay	Gullane Point North	Gullane Point South	Forth Estuary - Largo Bay
Site name	Dunstaffnage Bay	Ganavan	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay Razors	Saddell Bay Razors	Gullane North	Gullane South	Largo Bay
Whole weight									
µg/kg									
PCB18	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	0.02
PCB28	<0.01	<0.01	<0.01	<0.01	0.03	0.03	0.09	0.09	0.08
PCB31	<0.01	<0.01	<0.01	<0.01	0.02	0.02	0.07	0.07	0.06
PCB47	<0.01	<0.01	<0.01	<0.01	0.03	0.02	0.04	0.03	0.04
PCB49	<0.01	<0.01	<0.01	0.01	0.04	0.03	0.07	0.07	0.07
PCB51	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB52	<0.01	<0.01	<0.01	0.01	0.05	0.04	0.10	0.11	0.10
PCB99	<0.01	<0.01	<0.01	0.03	0.06	0.06	0.11	0.10	0.10
PCB101	<0.01	<0.01	<0.01	0.04	0.12	0.11	0.22	0.23	0.21
PCB105	<0.01	<0.01	<0.01	0.01	0.05	0.04	0.06	0.06	0.05
PCB114	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB118	<0.01	<0.01	<0.01	0.04	0.11	0.10	0.16	0.16	0.15
PCB123	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB128	<0.01	<0.01	<0.01	0.01	0.04	0.03	0.05	0.05	0.05
PCB138	0.01	0.02	<0.01	0.10	0.22	0.21	0.32	0.32	0.30
PCB153	0.01	0.02	<0.01	0.11	0.21	0.20	0.35	0.34	0.33
PCB156	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB157	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB167	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01
PCB180	<0.01	<0.01	<0.01	0.03	0.01	0.02	<0.01	<0.01	<0.01
PCB189	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SUM of ICES 6(µg/kg) lower	**0.02**	**0.04**	**<0.01**	**0.29**	**0.64**	**0.61**	**1.08**	**1.09**	**1.02**
SUM of ICES 6(µg/kg) upper	**0.06**	**0.08**	**0.06**	**0.30**	**0.64**	**0.61**	**1.09**	**1.10**	**1.03**
WHO-TEQ 2005 (pg/g) lower	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.01**	**0.01**	**0.01**
WHO-TEQ 2005 (pg/g) upper	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**

FERA LIMS Sample No.	S15-000679	S15-023706	S15-038579	S15-038712	S15-000387	S15-023880	S15-000424	S15-023928
Sample type	Pacific Oysters	Mussels	Mussels	Razors	Pacific Oysters	Mussels	Mussels	Razors
Production area	Loch Kanaird	Loch Leven Lower	Dornoch Firth	Broad Bay Aignish	Fairlie	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Site name	Ardmair	Lower	Meikle Ferry	Aiginish	Southannan Sands	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Whole weight								
µg/kg								
PCB18	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
PCB28	0.02	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01
PCB31	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01
PCB47	0.02	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	<0.01
PCB49	<0.01	<0.01	<0.01	0.01	0.10	0.01	<0.01	<0.01
PCB51	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB52	0.01	0.01	<0.01	0.02	0.17	0.03	<0.01	<0.01
PCB99	0.02	0.03	<0.01	0.02	0.25	0.06	<0.01	<0.01
PCB101	0.03	0.06	0.02i	0.05	0.41	0.13	0.02	0.10i
PCB105	<0.01	0.01	<0.01	0.01	0.10	0.04	<0.01	<0.01
PCB114	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB118	0.02	0.05	0.01	0.04	0.33	0.13	0.02	0.02
PCB123	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
PCB128	<0.01	0.02	<0.01	<0.01	0.05	0.03	<0.01	<0.01
PCB138	0.05	0.13	0.03	0.06	0.69	0.21	0.04	0.03
PCB153	0.09	0.16	0.04	0.07	1.16	0.21	0.06	0.04
PCB156	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
PCB157	<0.01	<0.01	<0.01	<0.01	0.01i	<0.01	<0.01	<0.01
PCB167	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01
PCB180	<0.01	0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01
PCB189	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SUM of ICES 6(µg/kg) lower	**0.20**	**0.37**	**0.09**	**0.20**	**2.58**	**0.58**	**0.12**	**0.17**
SUM of ICES 6(µg/kg) upper	**0.21**	**0.38**	**0.12**	**0.22**	**2.58**	**0.60**	**0.15**	**0.20**
WHO-TEQ 2005 (pg/g) lower	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.01**	**0.01**	**<0.01**	**<0.01**
WHO-TEQ 2005 (pg/g) upper	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.02**	**0.01**	**<0.01**	**<0.01**

Table 2.3: *Ortho* PCB concentrations – Lipid weight

FERA LIMS Sample No.	S15-006258	S15-038711	S15-003451	S15-038453	S15-003449	S15-024039	S15-000219	S15-000216	S15-000223
Sample type	Cockles	Cockles	Cockles	Cockles	Razors	Razors	Razors	Razors	Razors
Production area	Dunstaffnage Cockles	Kerrera Cockles	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay	Saddell Bay	Gullane Point North	Gullane Point South	Forth Estuary - Largo Bay
Site name	Dunstaffnage Bay	Ganavan	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay Razors	Saddell Bay Razors	Gullane North	Gullane South	Largo Bay
Lipid weight									
µg/kg									
PCB18	0.27	0.71	0.27	0.78	0.32	0.51	1.21	1.74	1.42
PCB28	0.67i	1.17	0.42	1.92	2.20	3.41	5.36	7.15	6.28
PCB31	0.53	0.99	0.49i	1.28	1.44	2.55	4.20	5.56	4.83
PCB47	0.90	0.65	0.50	1.72	2.04	3.00	2.41	2.67	2.80
PCB49	0.48	0.79	0.38	2.54	2.97	4.51	4.30	5.99	5.14
PCB51	0.18	0.07	0.10	0.21	0.27	0.29	0.26	0.32	0.30
PCB52	0.74	1.34	0.51	3.59	4.04	5.98	6.38	8.93	7.68
PCB99	0.83	1.32	0.63	6.56	5.00	7.96	6.42	8.21	7.35
PCB101	1.29	2.00	0.92	10.25	8.92	14.57	13.69	18.27	15.72
PCB105	0.46	0.63	0.31	3.30	3.54	5.43	3.48	4.60	4.08
PCB114	<0.06	0.02	<0.08	0.15	0.10	0.16	0.19	0.26	0.23
PCB118	1.60	2.05	1.06	9.23	8.39	13.44	9.96	12.61	11.51
PCB123	0.03	0.05	<0.02	0.28	0.22	0.19	0.36	0.34	0.42
PCB128	0.47	0.63	0.33	3.07	2.86	4.63	3.05	3.74	3.53
PCB138	3.34	4.53	2.38	24.03	16.98	28.46	19.31	25.30	22.48
PCB153	3.78	4.90	2.92	26.33	16.30	27.28	21.20	27.35	24.54
PCB156	0.19	0.25	0.13	1.04	0.60	0.94	0.53	0.71	0.60
PCB157	0.10	0.13	0.06	0.48	0.28	0.39	0.30	0.40	0.37
PCB167	0.20	0.23	0.13	0.65	0.39	0.53	0.70	0.85	0.77
PCB180	0.93	1.35	0.67	8.63	1.15	2.28	0.24	0.33	0.26
PCB189	<0.07	<0.18	<0.07	0.14i	0.08	0.11	0.06	0.05	0.09
SUM of ICES 6(µg/kg) lower	**10.75**	**15.29**	**7.82**	**74.75**	**49.59**	**81.98**	**66.18**	**87.33**	**76.96**
SUM of ICES 6(µg/kg) upper	**10.75**	**15.29**	**7.82**	**74.75**	**49.59**	**81.98**	**66.18**	**87.33**	**76.96**
WHO-TEQ 2005 (pg/g) lower	**0.08**	**0.10**	**0.05**	**0.46**	**0.41**	**0.64**	**0.47**	**0.59**	**0.54**
WHO-TEQ 2005 (pg/g) upper	**0.08**	**0.11**	**0.06**	**0.46**	**0.41**	**0.64**	**0.47**	**0.59**	**0.54**

FERA LIMS Sample No.	S15-000679	S15-023706	S15-038579	S15-038712	S15-000387	S15-023880	S15-000424	S15-023928
Sample type	Pacific Oysters	Mussels	Mussels	Razors	Pacific Oysters	Mussels	Mussels	Razors
Production area	Loch Kanaird	Loch Leven Lower	Dornoch Firth	Broad Bay Aignish	Fairlie	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Site name	Ardmair	Lower	Meikle Ferry	Aiginish	Southannan Sands	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Lipid weight								
µg/kg								
PCB18	0.31	0.16	0.43	0.23	1.02	0.31	0.26	0.25
PCB28	1.63	0.82	0.76	0.49	4.95	0.89	0.58	0.44
PCB31	0.74	0.59	0.79	0.47	3.70	0.73	0.57	0.38
PCB47	1.67	0.47	0.45	0.37	4.44	0.65	0.41	0.25
PCB49	0.89	0.69	0.85	0.51	7.16	1.21	0.58	0.30
PCB51	0.33	0.04	0.06	0.04	0.56	<0.03	0.04	0.04
PCB52	1.23	1.14	1.46	0.97	11.45	2.49	1.02	0.54
PCB99	1.87	2.51	1.49	1.19	16.92	5.44	1.89	0.68i
PCB101	2.79	4.71	3.58i	2.54	28.42	12.40	3.46	7.68i
PCB105	0.61	1.27	0.94	0.59	6.87	3.52	0.93	0.35
PCB114	0.04	0.06	0.05	0.02	0.34	0.10	0.05	<0.01
PCB118	2.42	4.08	2.93	2.02	22.90	12.50	3.03	1.29
PCB123	0.07	0.10	0.05	0.04	0.85	0.17	0.07	0.02
PCB128	0.36	1.40	0.67	0.50	3.57	3.32	0.90	0.34
PCB138	4.92	10.62	5.69	3.19	47.24	19.78	7.86	2.31
PCB153	8.65	13.92	7.06	3.65	79.54	20.08	10.89	2.92
PCB156	0.09	0.42	0.26	0.08	0.93	0.91	0.31	0.06
PCB157	0.07	0.19	0.12	0.04	0.81i	0.40	0.13	0.02
PCB167	0.21	0.38	0.23	0.07	1.86	0.79	0.24	0.07
PCB180	0.32	1.18	0.46	0.05	5.73	0.85iR	0.72	0.18
PCB189	0.03	0.06	0.06i	<0.01	0.02	0.05i	0.04	<0.01
SUM of ICES 6(µg/kg) lower	**19.54**	**32.39**	**19.01**	**10.89**	**177.33**	**56.49**	**24.53**	**14.07**
SUM of ICES 6(µg/kg) upper	**19.54**	**32.39**	**19.01**	**10.89**	**177.33**	**56.49**	**24.53**	**14.07**
WHO-TEQ 2005 (pg/g) lower	**0.11**	**0.20**	**0.14**	**0.09**	**1.04**	**0.55**	**0.14**	**0.05**
WHO-TEQ 2005 (pg/g) upper	**0.11**	**0.20**	**0.14**	**0.09**	**1.04**	**0.55**	**0.14**	**0.05**

Table 2.4: Summary of PCDD/F and PCB WHO-TEQ, and ICES-6 concentrations

FERA LIMS Sample No.	S15-006258	S15-038711	S15-003451	S15-038453	S15-003449	S15-024039	S15-000219	S15-000216	S15-000223
Sample Details:	Cockles	Cockles	Cockles	Cockles	Razors	Razors	Razors	Razors	Razors
Production area	Dunstaffnage Cockles	Kerrera Cockles	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay	Saddell Bay	Gullane Point North	Gullane Point South	Forth Estuary - Largo Bay
Site name	Dunstaffnage Bay	Ganavan	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay Razors	Saddell Bay Razors	Gullane North	Gullane South	Largo Bay
Fat content (% whole)	**0.4**	**0.4**	**0.3**	**0.4**	**1.3**	**0.7**	**1.6**	**1.2**	**1.3**
WHO TEQ 2005 pg/g whole									
Dioxin	0.03	0.03	0.03	0.05	0.10	0.08	0.10	0.10	0.09
non ortho-PCB	0.01	0.22	0.01	0.02	0.06	0.05	0.10	0.09	0.09
ortho-PCB	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01
Sum of WHO TEQs (upper)	**0.05**	**0.26**	**0.05**	**0.08**	**0.17**	**0.14**	**0.21**	**0.20**	**0.19**
WHO TEQ 2005 pg/g Fat									
Dioxin	5.35	4.18	4.99	7.93	7.55	10.61	6.17	7.88	7.07
non ortho-PCB	3.92	24.95	2.63	5.93	4.36	6.49	6.04	7.60	6.65
ortho-PCB	0.08	0.11	0.06	0.46	0.41	0.64	0.47	0.59	0.54
Sum of WHO TEQs (upper)	**9.35**	**29.24**	**7.68**	**14.32**	**12.32**	**17.74**	**12.68**	**16.07**	**14.26**
SUM of ICES 6 µg/kg whole (upper)	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
SUM of ICES 6 µg/kg fat (upper)	**0.08**	**0.11**	**0.06**	**0.46**	**0.41**	**0.64**	**0.47**	**0.59**	**0.54**

FERA LIMS Sample No.	S15-000679	S15-023706	S15-038579	S15-038712	S15-000387	S15-023880	S15-000424	S15-023928
Sample Details:	Pacific Oysters	Mussels	Mussels	Razors	Pacific Oysters	Mussels	Mussels	Razors
Production area	Loch Kanaird	Loch Leven Lower	Dornoch Firth	Broad Bay Aignish	Fairlie	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Site name	Ardmair	Lower	Meikle Ferry	Aiginish	Southannan Sands	East Burwick Mussels	Hamar Voe	Caolas Bhearnaraigh
Fat content (% whole)	**1.0**	**1.2**	**0.5**	**2.0**	**1.5**	**1.0**	**0.5**	**1.3**
WHO TEQ 2005 pg/g whole								
Dioxin	0.06	0.11	0.04	0.05	0.23	0.10	0.05	0.05
non ortho-PCB	0.03	0.05	0.02	0.03	0.14	0.08	0.02	0.02
ortho-PCB	<0.01	<0.01	<0.01	<0.01	0.02	0.01	<0.01	<0.01
Sum of WHO TEQs (upper)	**0.10**	**0.17**	**0.07**	**0.09**	**0.39**	**0.19**	**0.08**	**0.08**
WHO TEQ 2005 pg/g Fat								
Dioxin	5.77	9.42	5.43	2.39	15.69	9.27	8.47	2.88
non ortho-PCB	2.73	4.26	3.06	1.36	9.61	7.38	4.42	1.30
ortho-PCB	0.11	0.20	0.14	0.09	1.04	0.55	0.14	0.05
Sum of WHO TEQs (upper)	**8.61**	**13.88**	**8.63**	**3.84**	**26.34**	**17.20**	**13.03**	**4.23**
SUM of ICES 6 µg/kg whole (upper)	**0.21**	**0.38**	**0.12**	**0.22**	**2.58**	**0.60**	**0.15**	**0.20**
SUM of ICES 6 µg/kg fat (upper)	**19.54**	**32.39**	**19.01**	**10.89**	**177.33**	**56.49**	**24.53**	**14.07**

Table 2.5: PAH concentrations (µg/kg whole weight)

FERA LIMS No.	S15-000239	S15-020909	S15-006259	S15-040615	S15-006260
Description	Pacific Oysters	Pacific Oysters	Queen Scallops	Pacific Oysters	Razors
Production area	Loch Spelve - Groggan Pier	Otter Ferry	Loch Fyne - Stonefield	Loch Fyne - Stonefield	West Jura
Site name	Croggan Pier	Balliemore	Noth Bay	North Bay	Jura
µg/kg whole weight					
acenaphthylene	0.30	0.12	1.86	1.45	0.07
acenaphthene	<0.27	<0.37	<0.32	<0.39	<0.25
fluorene	<0.35	<0.43	0.53	<0.39	<0.34
phenanthrene	1.35	1.30	3.32	1.94	0.77
anthracene	0.10	0.14	0.51	0.34	0.05
fluoranthene	3.16	3.99	9.75i	4.60	1.55
benzo[c]fluorene	0.22	0.25	0.74	0.38	0.07
pyrene	2.54i	3.63	10.26i	3.37i	1.01
benzo[ghi]fluoranthene	1.77	1.75	5.06	1.73	0.58
benz (a) anthracene	**1.21**	**1.17**	**4.98**	**1.54**	**0.49**
benzo[b]naphtho[2,1-d]thiophene	0.23	0.25	0.82	0.29	0.08
cyclopenta[c,d]pyrene	0.25	0.16	0.41	0.11	<0.01
chrysene	**1.66**	**1.70**	**5.92**	**2.06**	**0.58**
5-methylchrysene	<0.05	<0.02	<0.47	<0.02	<0.04
benzo[b]fluoranthene	**5.01**	**2.97**	**11.43**	**5.79**	**1.20**
benzo[j]fluoranthene	1.26	0.91	5.88	1.54	0.46
benzo[k]fluoranthene	1.92	1.39	6.04i	2.55	0.54
benzo[e]pyrene	3.69	3.31	10.66	6.14	1.25
benzo[a]pyrene	**0.78**	**0.60**	**6.06**	**1.16**	**0.35**
indeno[1,2,3-cd]pyrene	0.85	0.49	4.35	1.28	0.39
dibenz[ah]anthracene	0.22	0.11	1.09	0.35	0.06
benzo-[g,h,i]perylene	0.98	0.67	3.94	1.49	0.39
anthanthrene	<0.1	<0.1	0.15	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	0.43	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	0.43	0.13	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.12	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	0.93	0.40	<0.1
PAH 4 Sum Lower µg/kg	**8.66**	**6.44**	**28.39**	**10.55**	**2.62**
PAH 4 Sum Upper µg/kg	**8.66**	**6.44**	**28.39**	**10.55**	**2.62**

FERA LIMS No.	S15-006258	S15-038711	S15-003451	S15-038453	S15-003449
Description	Cockles	Cockles	Cockles	Cockles	Razors
Production area	Dunstaffnage Cockles	Kerrera Cockles	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay
Site name	Dunstaffnage Bay	Ganavan	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay Razors
µg/kg whole weight					
acenaphthylene	<0.06	<0.32	<0.07	0.25	0.35
acenaphthene	<0.26	<0.43	<0.26	<0.3	<0.25
fluorene	<0.34	<0.49	<0.34	<0.29	0.41
phenanthrene	<0.57	<0.69	<0.57	0.71	2.01
anthracene	0.02	<0.03	0.03	0.11	0.26
fluoranthene	0.65	0.79	0.58	1.70	4.82
benzo[c]fluorene	0.04	0.05	0.04	0.09	0.30
pyrene	0.66i	0.60i	0.52i	1.89	5.09i
benzo[ghi]fluoranthene	0.34	0.35	0.34	0.73	1.29
benz (a) anthracene	**0.36**	**0.33**	**0.36**	**0.88**	**2.70**
benzo[b]naphtho[2,1-d]thiophene	0.08	0.10	0.07	0.16	0.36
cyclopenta[c,d]pyrene	0.05	0.03	0.05	0.03	0.04
chrysene	**0.59**	**0.59**	**0.67**	**1.01**	**2.94**
5-methylchrysene	<0.01	<0.01	<0.01	<0.02	<0.03
benzo[b]fluoranthene	**0.78**	**0.76**	**0.78**	**1.49**	**3.91**
benzo[j]fluoranthene	0.41	0.42	0.50	0.82	1.95
benzo[k]fluoranthene	0.47	0.43	0.48	0.95	2.01
benzo[e]pyrene	0.85	0.89	0.83	2.10	3.84
benzo[a]pyrene	**0.38**	**0.32**	**0.41**	**1.00**	**2.25**
indeno[1,2,3-cd]pyrene	0.56	0.56	0.56	1.12	1.25
dibenz[ah]anthracene	0.09	0.10	0.10	0.21	0.24
benzo-[g,h,i]perylene	0.53	0.57	0.50	1.30	1.42
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	0.13	<0.1	0.14	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.13	<0.1	0.18	<0.13
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	0.24	<0.1	0.38	0.13
PAH 4 Sum Lower µg/kg	**2.11**	**2.00**	**2.22**	**4.38**	**11.80**
PAH 4 Sum Upper µg/kg	**2.11**	**2.00**	**2.22**	**4.38**	**11.80**

FERA LIMS No.	S15-024039	S15-000369	S15-000676	S15-000219
Description	Razors	Native Oysters	Razors	Razors
Production area	Saddell Bay	Loch Ryan	Luce Bay	Gullane Point North
Site name	Saddell Bay Razors	Loch Ryan	Luce Sand Razors	Gullane North
µg/kg whole weight				
acenaphthylene	0.74	<0.29	0.30	0.40
acenaphthene	<0.3	0.31	<0.27	<0.4
fluorene	0.56	0.50	0.41	0.71
phenanthrene	2.25	3.90	2.16	3.01
anthracene	0.30	0.20	0.13	0.43
fluoranthene	4.68	6.99	3.92	6.24i
benzo[c]fluorene	0.38	0.40	0.20	0.46
pyrene	5.13i	3.75i	2.63i	6.03i
benzo[ghi]fluoranthene	1.22	1.99	1.17	1.92
benz (a) anthracene	**2.64**	**2.04**	**1.21**	**2.42**
benzo[b]naphtho[2,1-d]thiophene	0.42	0.44	0.23	0.39
cyclopenta[c,d]pyrene	0.04	0.11	0.01	0.06
chrysene	**3.28**	**2.31**	**1.33**	**2.19**
5-methylchrysene	<0.02	<0.03	<0.01	<0.02
benzo[b]fluoranthene	**3.53**	**4.42**	**2.12**	**2.52**
benzo[j]fluoranthene	1.62	1.71	0.88	1.13
benzo[k]fluoranthene	2.09	4.19	1.04	1.27
benzo[e]pyrene	3.12	3.14	2.17	2.86
benzo[a]pyrene	**1.97**	**1.19**	**0.81**	**1.54**
indeno[1,2,3-cd]pyrene	1.08	1.40	0.66	0.87
dibenz[ah]anthracene	0.21	0.33	0.11	0.17
benzo-[g,h,i]perylene	1.23	1.39	0.72	1.17
anthanthrene	<0.1	<0.1	<0.1	0.11
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	0.15	<0.1	<0.1	<0.11
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1
coronene	0.32	0.11	<0.1	0.14
PAH 4 Sum Lower µg/kg	**11.42**	**9.96**	**5.47**	**8.67**
PAH 4 Sum Upper µg/kg	**11.42**	**9.96**	**5.47**	**8.67**

FERA LIMS No.	S15-000216	S15-000121	S15-000223	S15-000679	S15-040049
Description	Razors	Surf Clam	Razors	Pacific Oysters	King Scallops
Production area	Gullane Point South	Firth of Forth North	Forth Estuary - Largo Bay	Loch Kanaird	Loch Ewe & Loch Thurnaig
Site name	Gullane South	Anstruther	Largo Bay	Ardmair	Loch Ewe
µg/kg whole weight					
acenaphthylene	0.45	<0.38	0.44	<0.04	0.26
acenaphthene	0.32	<0.31	0.38	<0.25	<0.39
fluorene	0.66	<0.36	0.73	<0.33	<0.39
phenanthrene	2.87	1.17	3.07	0.74	0.77
anthracene	0.42	0.25	0.41	0.08	0.07
fluoranthene	6.00i	1.68	6.38i	1.08	2.20
benzo[c]fluorene	0.37	0.14	0.49	0.06	0.06
pyrene	5.17i	1.70i	6.23i	1.28	1.39
benzo[ghi]fluoranthene	1.86	0.54	1.93	0.42	1.93
benz (a) anthracene	**2.42**	**0.83**	**2.48**	**0.23**	**0.82**
benzo[b]naphtho[2,1-d]thiophene	0.37	0.14	0.39	0.06	0.16
cyclopenta[c,d]pyrene	0.05	0.02	0.06	0.04	0.08
chrysene	**2.17**	**0.89**	**2.25**	**0.36**	**1.05**
5-methylchrysene	<0.03	<0.01	<0.03	<0.01	<0.01
benzo[b]fluoranthene	**2.46**	**1.04**	**2.52**	**0.66**	**1.90**
benzo[j]fluoranthene	1.12	0.50	1.17	0.15	0.77
benzo[k]fluoranthene	1.24	0.56	1.27	0.29	1.03
benzo[e]pyrene	2.93	1.25	2.88	0.65	1.48
benzo[a]pyrene	**1.42**	**0.74**	**1.58**	**0.08**	**0.64**
indeno[1,2,3-cd]pyrene	0.80	0.73	0.89	0.10	0.29
dibenz[ah]anthracene	0.15	0.12	0.16	<0.04	0.07
benzo-[g,h,i]perylene	1.09	1.06	1.17	0.15	0.24
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	0.29	0.35	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.12	<0.11	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	0.14	0.17	0.14	<0.1	<0.1
PAH 4 Sum Lower µg/kg	**8.47**	**3.50**	**8.83**	**1.33**	**4.41**
PAH 4 Sum Upper µg/kg	**8.47**	**3.50**	**8.83**	**1.33**	**4.41**

FERA LIMS No.	S15-023705	S15-023706	S15-040524	S15-040523	S15-000388
Description	Mussels	Mussels	Mussels	Mussels	Mussels
Production area	Loch Leven Upper	Loch Leven Lower	Loch Leven Upper	Loch Leven Lower	Loch Inchard
Site name	Upper	Lower	Upper	Lower	Loch Inchard - Site 1 - D. Ross
µg/kg whole weight					
acenaphthylene	0.13	0.16	0.39	0.30	0.65i
acenaphthene	<0.37	<0.37	<0.39	<0.39	4.44
fluorene	<0.43	<0.43	0.41	<0.4	4.05i
phenanthrene	1.04	1.69	2.59	1.46	26.59i
anthracene	0.17	0.48	0.41	0.21	7.59i
fluoranthene	2.14	3.90	5.20	3.00	3.68i
benzo[c]fluorene	0.17	0.42	0.42	0.24	3.51
pyrene	2.05	5.14	4.55	2.60	4.57i
benzo[ghi]fluoranthene	1.14	2.54	**2.17**	1.25	2.34
benz (a) anthracene	**1.04**	**2.38**	**1.80**	**1.23**	**4.11**
benzo[b]naphtho[2,1-d]thiophene	0.22	0.77	0.46	0.32	2.97
cyclopenta[c,d]pyrene	0.17	0.17	0.16	0.11	0.04
chrysene	**1.42**	**4.15**	**3.12**	**2.17**	**7.30**
5-methylchrysene	<0.02	<0.07	<0.02	<0.01	<0.05
benzo[b]fluoranthene	**5.99**	**32.96**	**8.63**	**5.94**	**3.39**
benzo[j]fluoranthene	1.84	20.30	2.35	1.75	1.12
benzo[k]fluoranthene	2.48	10.21	3.13	2.18	1.16
benzo[e]pyrene	7.90	15.84	13.27	8.88	3.62
benzo[a]pyrene	**1.51**	**7.59**	**2.13**	**1.38**	**0.93**
indeno[1,2,3-cd]pyrene	1.96	6.53	1.82	1.41	0.71
dibenz[ah]anthracene	0.34	1.36	0.39	0.28	0.17
benzo-[g,h,i]perylene	3.55	11.40	3.08	2.28	1.05
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	0.27	0.14	<0.1	0.23	<0.1
dibenzo[a,e]pyrene	0.33	1.20	0.30	0.23	<0.1
dibenzo[a,i]pyrene	<0.1	0.16	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	0.52	1.27	0.63	0.51	<0.1
PAH 4 Sum Lower µg/kg	**9.96**	**47.08**	**15.68**	**10.72**	**15.73**
PAH 4 Sum Upper µg/kg	**9.96**	**47.08**	**15.68**	**10.72**	**15.73**

FERA LIMS No.	S15-000394	S15-024036	S15-038579	S15-038712	S15-023929
Description	Mussels	Pacific Oysters	Mussels	Razors	Mussels
Production area	Loch Glencoul	Kyle of Tongue	Dornoch Firth 2	Broad Bay Aignish	Loch Leurbost
Site name	Kylesku	Kyle of Tongue	Meikle Ferry	Aiginish	Eilean Mhiabhaing
µg/kg whole weight					
acenaphthylene	<0.29	0.09	0.22	<0.32	0.44
acenaphthene	<0.27	<0.3	<0.3	<0.42	<0.3
fluorene	0.42	<0.29	0.53	<0.49	<0.29
phenanthrene	1.56	0.60	1.83	1.33	1.02
anthracene	0.08	0.04	0.10	0.10	0.11
fluoranthene	1.14	1.59	1.81	2.47	1.55
benzo[c]fluorene	0.06	0.06	0.10	0.14	0.09
pyrene	1.23	0.92	1.70	1.47	1.32
benzo[ghi]fluoranthene	0.50	0.69	0.65	0.68	0.79
benz (a) anthracene	**0.23**	**0.29**	**0.45**	**0.67**	**0.43**
benzo[b]naphtho[2,1-d]thiophene	0.05	0.07	0.09	0.10	0.08
cyclopenta[c,d]pyrene	0.02	0.02	<0.01	0.03	0.04
chrysene	**0.33**	**0.48**	**0.62**	**0.79**	**0.58**
5-methylchrysene	<0.01	<0.01	<0.01	<0.01	<0.01
benzo[b]fluoranthene	**0.79**	**1.47**	**0.77**	**1.19**	**1.27**
benzo[j]fluoranthene	0.28	0.31	0.34	0.52	0.49
benzo[k]fluoranthene	0.26	0.56	0.28	0.52	0.43
benzo[e]pyrene	0.98	1.42	0.86	1.18	2.35
benzo[a]pyrene	**0.12**	**0.13**	**0.24**	**0.40**	**0.19**
indeno[1,2,3-cd]pyrene	0.39	0.30	0.39	0.45	0.43
dibenz[ah]anthracene	0.05	0.05	0.06	<0.05	0.05
benzo-[g,h,i]perylene	0.60	0.39	0.53	0.46	0.85
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1	0.47
dibenzo[a,e]pyrene	<0.1	<0.1	0.13	<0.11	<0.13
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	0.22	0.18	0.30
PAH 4 Sum Lower µg/kg	**1.47**	**2.37**	**2.08**	**3.05**	**2.47**
PAH 4 Sum Upper µg/kg	**1.47**	**2.37**	**2.08**	**3.05**	**2.47**

FERA LIMS No.	S15-024041	S15-038370	S15-000387	S15-000674	S15-006257
Description	Mussels	Mussels	Pacific Oysters	Mussels	Mussels
Production area	East Loch Tarbert	Loch Roag: Barraglom	Fairlie	Stromness Voe	Clift Sound - Booth
Site name	Sound of Scalpay	Loch Barraglom	Southannan Sands	Burra Holm	Booth
µg/kg whole weight					
acenaphthylene	0.18	0.11	0.99	0.14	0.46
acenaphthene	<0.3	<0.3	0.46	<0.25	<0.25
fluorene	<0.29	<0.29	0.73	<0.33	<0.34
phenanthrene	0.96	0.74	3.61	<0.56	1.31
anthracene	0.08	0.06	0.71	0.05	0.11
fluoranthene	1.31	0.77	12.81i	1.04	2.11
benzo[c]fluorene	0.07	0.04	0.71	0.08	0.21
pyrene	0.85	0.69	12.30i	1.46	2.92i
benzo[ghi]fluoranthene	0.60	0.38	4.47	0.78	1.26
benz (a) anthracene	**0.29**	**0.16**	**4.19**	**0.63**	**0.74**
benzo[b]naphtho[2,1-d]thiophene	0.07	0.04	0.86	0.10	0.12
cyclopenta[c,d]pyrene	0.04	0.01	0.17	0.08	0.13
chrysene	**0.41**	**0.31**	**4.90**	**0.98**	**1.06**
5-methylchrysene	<0.01	<0.01	<0.04	<0.02	<0.01
benzo[b]fluoranthene	**0.94**	**0.64**	**7.25**	**2.09**	**1.99**
benzo[j]fluoranthene	0.33	0.21	2.22	0.84	0.74
benzo[k]fluoranthene	0.33	0.21	3.60i	0.78	0.73
benzo[e]pyrene	1.49	0.85	7.74	1.73	2.88
benzo[a]pyrene	**0.15**	**0.10**	**2.42**	**0.40**	**0.46**
indeno[1,2,3-cd]pyrene	0.41	0.30	1.33	0.72	0.73
dibenz[ah]anthracene	0.04	<0.04	0.38	0.10	0.08
benzo-[g,h,i]perylene	0.68	0.43	2.02	1.04	1.08
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1	0.18
dibenzo[a,e]pyrene	<0.14	<0.11	<0.12	<0.1	<0.1
dibenzo[a,i]pyrene	<0.1	<0.1	0.10	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	0.26	0.18	0.12	0.11	0.11
PAH 4 Sum Lower µg/kg	**1.79**	**1.21**	**18.76**	**4.10**	**4.25**
PAH 4 Sum Upper µg/kg	**1.79**	**1.21**	**18.76**	**4.10**	**4.25**

FERA LIMS No.	S15-000675	S15-000218	S15-000120	S15-000221	S15-023880
Description	Mussels	Mussels	Mussels	Mussels	Mussels
Production area	Vaila Sound: East of Linga & Galtaskerry	Baltasound Mussels	Olnafirth Inner	Mid Yell Voe	East Burwick Mussels
Site name	Whitesness	Baltasound Harbour	Inner	Seafield	East Burwick Mussels
µg/kg whole weight					
acenaphthylene	<0.30	<0.37	<0.38	<0.29	0.26
acenaphthene	<0.27	<0.4	<0.31	<0.27	<0.3
fluorene	<0.35	<0.45	<0.36	<0.35	<0.29
phenanthrene	0.76	<0.68	<0.53	1.14	0.90
anthracene	0.06	0.08	0.03	0.08	0.07
fluoranthene	1.09	0.70	0.64	1.35	1.11
benzo[c]fluorene	0.06	0.05	0.05	0.09	0.07
pyrene	1.39	0.88	0.88	1.69	1.15
benzo[ghi]fluoranthene	0.73	0.38	0.53	0.87	0.64
benz (a) anthracene	**0.53**	**0.28**	**0.65**	**0.57**	**0.46**
benzo[b]naphtho[2,1-d]thiophene	0.10	0.05	0.08	0.10	0.12
cyclopenta[c,d]pyrene	0.07	0.07	0.06	0.21	0.04
chrysene	**0.90**	**0.49**	**0.96**	**0.97**	**0.87**
5-methylchrysene	<0.01	<0.01	<0.03	<0.01	<0.01
benzo[b]fluoranthene	**1.56**	**0.69**	**1.84**	**1.21**	**1.53**
benzo[j]fluoranthene	0.61	0.29	0.88	0.49	0.62
benzo[k]fluoranthene	0.53	0.23	0.83	0.42	0.57
benzo[e]pyrene	1.66	0.71	1.11	1.33	1.86
benzo[a]pyrene	**0.29**	**0.16**	**0.50**	**0.24**	**0.28**
indeno[1,2,3-cd]pyrene	0.54	0.27	0.83	0.34	0.59
dibenz[ah]anthracene	0.06	<0.04	0.12	0.04	0.07
benzo-[g,h,i]perylene	0.73	0.42	0.93	0.52	0.80
anthanthrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.1	<0.14
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	0.10	<0.1	0.29
PAH 4 Sum Lower µg/kg	**3.28**	**1.62**	**3.95**	**2.99**	**3.14**
PAH 4 Sum Upper µg/kg	**3.28**	**1.62**	**3.95**	**2.99**	**3.14**

FERA LIMS No.	S15-000424	S15-023658	S15-023927	S15-023928
Description	Mussels	Cockles	Cockles	Razors
Production area	Hamar Voe	Traigh Mhor	North Ford	Caolas Bhearnaraigh
Site name	Hamar Voe	Traigh Mhor	Oitir Mhor	Caolas Bhearnaraigh
µg/kg whole weight				
acenaphthylene	<0.3	<0.07	0.10	<0.04
acenaphthene	<0.27	<0.36	<0.3	<0.3
fluorene	0.37	<0.42	<0.29	<0.29
phenanthrene	2.08	<0.62	0.49	0.63
anthracene	0.08	<0.03	0.04	0.04
fluoranthene	1.21i	<0.34	0.73	1.32
benzo[c]fluorene	0.08	0.02	0.03	0.08
pyrene	2.04i	<0.32	0.49	0.72
benzo[ghi]fluoranthene	0.62	0.12	0.23	0.48
benz (a) anthracene	**0.31**	**0.09**	**0.18**	**0.35**
benzo[b]naphtho[2,1-d]thiophene	0.08	0.03	0.06	0.08
cyclopenta[c,d]pyrene	0.09	0.01	<0.01	0.02
chrysene	**0.63**	**0.19**	**0.46**	**0.63**
5-methylchrysene	<0.01	<0.01	<0.01	<0.01
benzo[b]fluoranthene	**0.84**	**0.22**	**0.39**	**0.89**
benzo[j]fluoranthene	0.25	0.12	0.21	0.34
benzo[k]fluoranthene	0.27	0.14	0.18	0.39
benzo[e]pyrene	0.86	0.26	0.42	0.94
benzo[a]pyrene	**0.14**	**<0.12**	**0.16**	**0.21**
indeno[1,2,3-cd]pyrene	0.24	0.17	0.28	0.33
dibenz[ah]anthracene	<0.04	<0.04	0.04	<0.03
benzo-[g,h,i]perylene	0.31	0.15	0.26	0.31
anthanthrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,l]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,e]pyrene	<0.1	<0.1	<0.1	<0.11
dibenzo[a,i]pyrene	<0.1	<0.1	<0.1	<0.1
dibenzo[a,h]pyrene	<0.1	<0.1	<0.1	<0.1
coronene	<0.1	<0.1	0.11	0.13
PAH 4 Sum Lower µg/kg	**1.92**	**0.50**	**1.19**	**2.08**
PAH 4 Sum Upper µg/kg	**1.92**	**0.62**	**1.19**	**2.08**

Table 2.6: Heavy metal concentrations (mg/kg whole weight)

Fera LIMS Sample No.	S15-000239	S15-020909	S15-006259	S15-006260	S15-006258	S15-038711	S15-003451	S15-038453	S15-003449	S15-024039
Sample type	Pacific Oysters	Pacific Oysters	Queen Scallops	Razors	Cockles	Cockles	Cockles	Cockles	Razors	Razors
Production area	Loch Spelve - Groggan Pier	Otter Ferry	Loch Fyne - Stonefield	West Jura	Dunstaffnage Cockles	Kerrera Cockles	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay	Saddell Bay
Site name	Croggan Pier	Balliemore	Noth Bay	Jura	Dunstaffnage Bay	Ganavan	Kilfinichen Bay	Loch Riddon Cockles	Machrie Bay Razors	Saddell Bay Razors
Cr	~0.08	~0.08	0.16	0.15	0.64	0.35	0.5	0.24	0.36	0.21
Mn	2.95	3.42	33.8	1.1	2.44	3.3	1.58	5.37	3	2.47
Co	0.021	0.026	0.075	0.064	0.23	0.279	0.168	0.242	0.134	0.094
Ni	~0.05	~0.06	0.16	~0.07	2.8	4.03	2.3	3.59	0.1	~0.09
Cu	7.84	12.4	3.15	1.06	0.8	0.44	0.4	0.39	1.37	1.13
Zn	383	199	42.5	14.2	7.93	7.01	5.89	8.15	16	14.4
As	1.35	1.59	1.96	1.48	1.25	1.25	1.21	1.22	2.36	1.86
Se	0.305	0.242	0.806	0.303	0.276	0.221	0.203	0.279	0.586	0.417
Ag	0.519	0.998	1.43	0.356	~0.006	~0.006	~0.003	0.018	0.431	0.15
Cd	0.247	0.259	0.527	0.025	0.053	0.038	0.038	0.038	0.233	0.152
Hg	0.011	0.018	0.022	0.016	0.014	0.018	0.007	0.016	0.056	0.039
Pb	0.065	0.05	0.322	0.061	0.103	0.122	0.045	0.128	0.106	0.059

' ~ ' indicates the measured value was above LoD but below LoQ

Fera LIMS Sample No.	S15-000369	S15-000676	S15-000219	S15-000216	S15-000121	S15-000223	S15-000679	S15-040049	S15-023705
Sample type	Native Oysters	Razors	Razors	Razors	Surf Clam	Razors	Pacific Oysters	King Scallops	Mussels
Production area	Loch Ryan	Luce Bay	Gullane Point North	Gullane Point South	Firth of Forth North	Forth Estuary - Largo Bay	Loch Kanaird	Loch Ewe & Loch Thurnaig	Loch Leven Upper
Site name	Loch Ryan	Luce Sand Razors	Gullane North	Gullane South	Anstruther	Largo Bay	Ardmair	Loch Ewe	Upper
Cr	~0.08	0.26	0.46	0.19	0.22	0.17	~0.06	<0.03	0.13
Mn	2.95	1.35	3.32	2.11	2.82	1.98	2.9	6.27	3.41
Co	0.026	0.074	0.091	0.062	0.125	0.074	0.02	0.013	0.035
Ni	~0.06	~0.07	0.13	~0.08	0.24	~0.09	~0.05	~0.06	0.1
Cu	15.5	1.25	1.34	1.31	1.23	1.38	5.94	0.6	0.67
Zn	248	14.2	15.6	15.3	8.32	15.3	147	22.4	9.58
As	1.38	1.79	1.31	1.29	1.27	1.27	1.8	1.52	1.46
Se	0.44	0.299	0.305	0.273	0.327	0.289	0.293	0.295	0.362
Ag	1.53	0.528	0.092	0.104	0.119	0.099	0.321	0.024	~0.006
Cd	0.314	0.031	0.033	0.027	0.068	0.026	0.296	0.292	0.06
Hg	0.017	0.025	0.01	0.011	0.011	0.013	0.016	0.012	0.016
Pb	0.056	0.114	0.513	0.103	0.113	0.1	0.08	0.081	0.107

' ~ ' indicates the measured value was above LoD but below LoQ

Fera LIMS Sample No.	S15-023706	S15-000388	S15-000394	S15-024036	S15-038579	S15-038712	S15-023929	S15-024041	S15-038370	S15-000387
Sample type	Mussels	Mussels	Mussels	Pacific Oysters	Mussels	Razors	Mussels	Mussels	Mussels	Pacific Oysters
Production area	Loch Leven Lower	Loch Inchard	Loch Glencoul	Kyle of Tongue	Dornoch Firth 2	Broad Bay Aignish	Loch Leurbost	East Loch Tarbert	Loch Roag: Barraglom	Fairlie
Site name	Lower	Loch In chard - Site 1 - D. Ross	Kylesku	Kyle of Tongue	Meikle Ferry	Aiginish	Eilean Mhiabhaing	Sound of Scalpay	Loch Barraglom	Southannan Sands
Cr	0.12	0.13	0.31	~0.06	0.35	0.19	0.13	0.17	0.12	0.18
Mn	3.77	2.33	3.2	1.51	4.28	1.09	1.12	1.42	0.86	6.02
Co	0.04	0.045	0.048	0.022	0.059	0.038	0.038	0.035	0.025	0.042
Ni	~0.09	0.1	0.17	~0.07	0.21	~0.05	0.1	0.14	0.12	~0.05
Cu	0.73	1.15	1	5.2	0.57	0.84	0.88	0.65	0.71	16.2
Zn	10.1	13.4	13.5	138	6.83	13.9	16.1	10.8	11.5	287
As	1.87	2.33	2.04	1.29	1.55	1.57	2.05	1.43	1.49	2.47
Se	0.44	0.573	0.461	0.217	0.293	0.244	0.421	0.314	0.333	0.359
Ag	~0.008	0.011	~0.009	0.483	0.01	0.043	~0.007	~0.006	~0.006	0.837
Cd	0.062	0.104	0.094	0.288	0.116	0.038	0.092	0.061	0.06	0.194
Hg	0.02	0.013	0.012	0.015	0.022	0.011	0.014	0.01	0.014	0.021
Pb	0.104	0.109	0.174	0.042	0.141	0.051	0.124	0.143	0.098	0.132

' ~ ' indicates the measured value was above LoD but below LoQ

Fera LIMS Sample No.	S15-000674	S15-006257	S15-000675	S15-000218	S15-000120	S15-000221	S15-023880	S15-000424	S15-023658	S15-023927	S15-023928
Sample type	Mussels	Mussels	Mussels	Mussels	Mussels	Mussels	Mussels	Mussels	Cockles	Cockles	Razors
Production area	Stromness Voe	Clift Sound - Booth	Vaila Sound: East of Linga & Galtaskerry	Baltasound Mussels	Olnafirth Inner	Mid Yell Voe	East Burwick Mussels	Hamar Voe	Traigh Mhor	North Ford	Caolas Bhearnaraigh
Site name	Burra Holm	Booth	Whitesness	Baltasound Harbour	Inner	Seafield	East Burwick Mussels	Hamar Voe	Traigh Mhor	Oitir Mhor	Caolas Bhearnaraigh
Cr	0.16	0.16	0.14	0.58	0.18	0.1	0.13	~0.09	0.18	0.39	0.14
Mn	2.54	1.1	2.34	1.09	0.75	1.03	0.74	0.62	0.77	2.14	1
Co	0.05	0.036	0.026	0.063	0.034	0.03	0.031	0.015	0.082	0.12	0.033
Ni	0.13	0.12	0.11	0.57	0.13	~0.06	0.1	~0.05	1.64	3.08	~0.06
Cu	0.85	1.25	0.98	0.92	0.67	1	0.82	0.54	0.28	0.42	0.97
Zn	32.2	22.8	25.1	18.9	25.6	18.4	20.9	13.2	6.88	6.97	14
As	1.59	1.51	1.53	1.49	1.57	1.59	1.41	1.02	1.12	2.42	1.58
Se	0.425	0.356	0.42	0.462	0.316	0.394	0.377	0.29	0.183	0.249	0.205
Ag	~0.006	<0.003	~0.003	~0.006	~0.004	~0.003	<0.003	<0.003	0.014	0.075	0.06
Cd	0.129	0.084	0.134	0.158	0.178	0.09	0.161	0.092	0.09	0.064	0.028
Hg	0.015	0.013	0.01	0.009	0.011	0.009	0.008	~0.006	0.008	0.022	0.016
Pb	0.22	0.217	0.179	0.138	0.271	0.081	0.163	0.066	0.039	0.057	0.046

' ~ ' indicates the measured value was above LoD but below LoQ

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